news & features

13 March 2003

Scaffold delivered through a needle

Tissue engineering uses a biodegradable scaffold as a matrix for new tissue growth. Now the scaffold can be injected as a liquid and then self-assembled on command within a wound.

PHILIP BALL

© GettyImages

An injectable scaffold for tissue engineering, which self-assembles *in situ* into a porous, biodegradable matrix, has been devised by scientists in England. The material helps tissues to regrow, forming a shaped solid support within a body cavity without the need to be implanted by an invasive operation.

Injectable scaffolds — made from polymer gels — that can be seeded and colonized by cells have been reported before. But they are not highly porous, so it is hard to disperse cells evenly throughout them, or to colonize them with fresh tissue. The new material has pores up to a tenth of a millimetre wide, and forms an intimate composite of scaffold and cells.

It is made from micro- or nanoparticles of a biodegradable polymer such as poly (lactic acid), one of the few substances approved for use as a tissue-engineering scaffold by the US Food and Drugs Administration. The particles can be mixed with seed cells and injected as a slurry into the body — for example, into a wound cavity of unknown shape.

This suspension can then be converted to a porous matrix by adding a crosslinking agent, again by injection. Each of the particles, which may be just a few hundred nanometres in diameter, contains several biotin groups on its surface, tethered by flexible chains of poly(ethylene glycol). Biotin is

- Genetics
- Immunology
- Materials
- Medical Research
- Microbiology NEW!
- Molecular Cell Biology
- Neuroscience
- Pharmacology
- Physics

browse all publications

a small organic molecule that is strongly bound by the multidentate protein avidin. So when avidin is added to the particle slurry, it joins the particles into a network, within which the seed cells are uniformly dispersed.

The idea is that these cells will then multiply within the body and unite with existing tissue, healing the wound. This process can be promoted by attaching other proteins to the particle surfaces: for example, growth factors, or peptides that assist cell adhesion.

Kevin Shakesheff of the University of Nottingham and co-workers, who have developed this system, first studied the integrity of their self-assembling scaffolds *ex vivo* by co-injecting the nanoparticles, cells and avidin into a pyramidal mould. They found that at the correct avidin concentration, the mixture solidified into a scaffold with pores between 5 and 100 micrometres wide.

This porous structure is critical for *in vivo* tissue regeneration because it allows a vascular network to penetrate into the scaffold. Without vasculature, seed cells may not be able to grow into viable tissue.

The researchers found that vascularization takes place when the scaffold is injected into the chorioallantoic membrane of chick embryos (this is the highly vascularized membrane that surrounds the growing embryo). And if the material is used to fill a gap cut within the femur of chick embryos, new bone, complete with a vascular system, begins to grow into the matrix within a week.

Porous polymer and cell composites that self-assemble *in situ*.
Salem *et al.* *Advanced Materials* **15,** 210–213 (2003).
Article